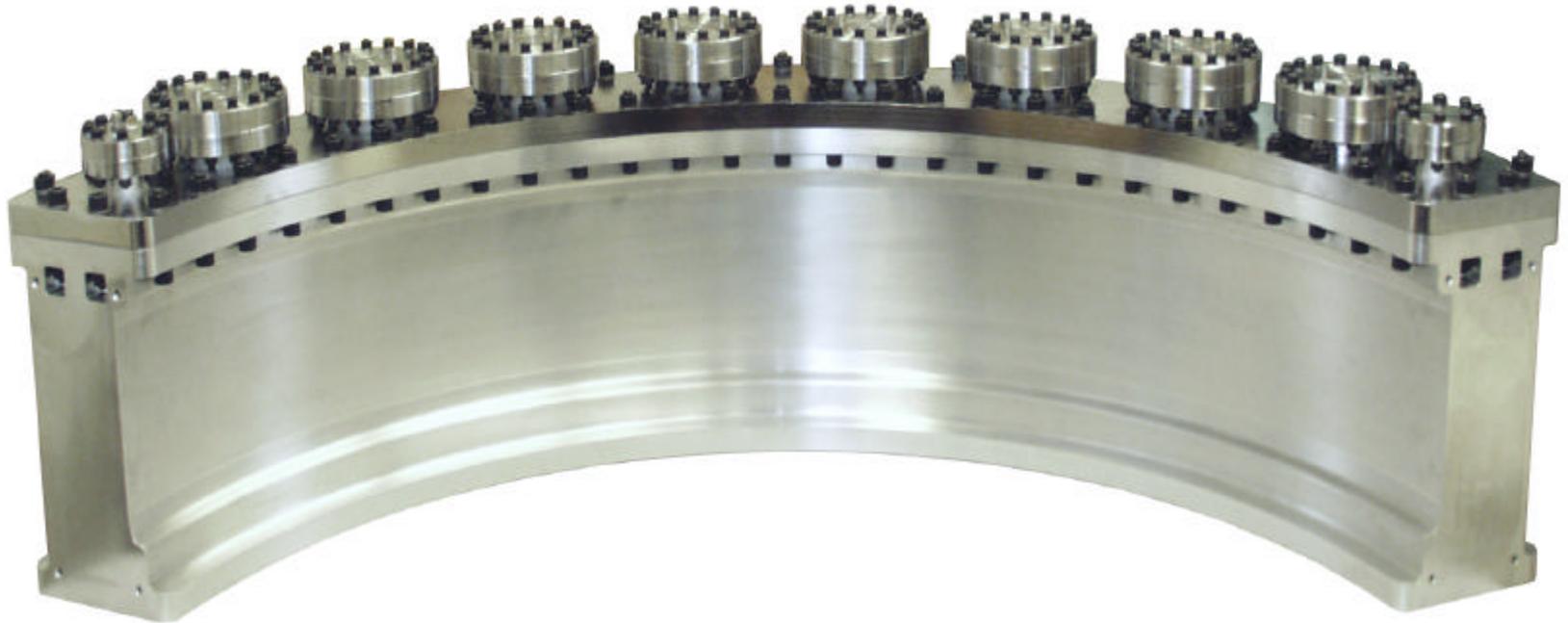
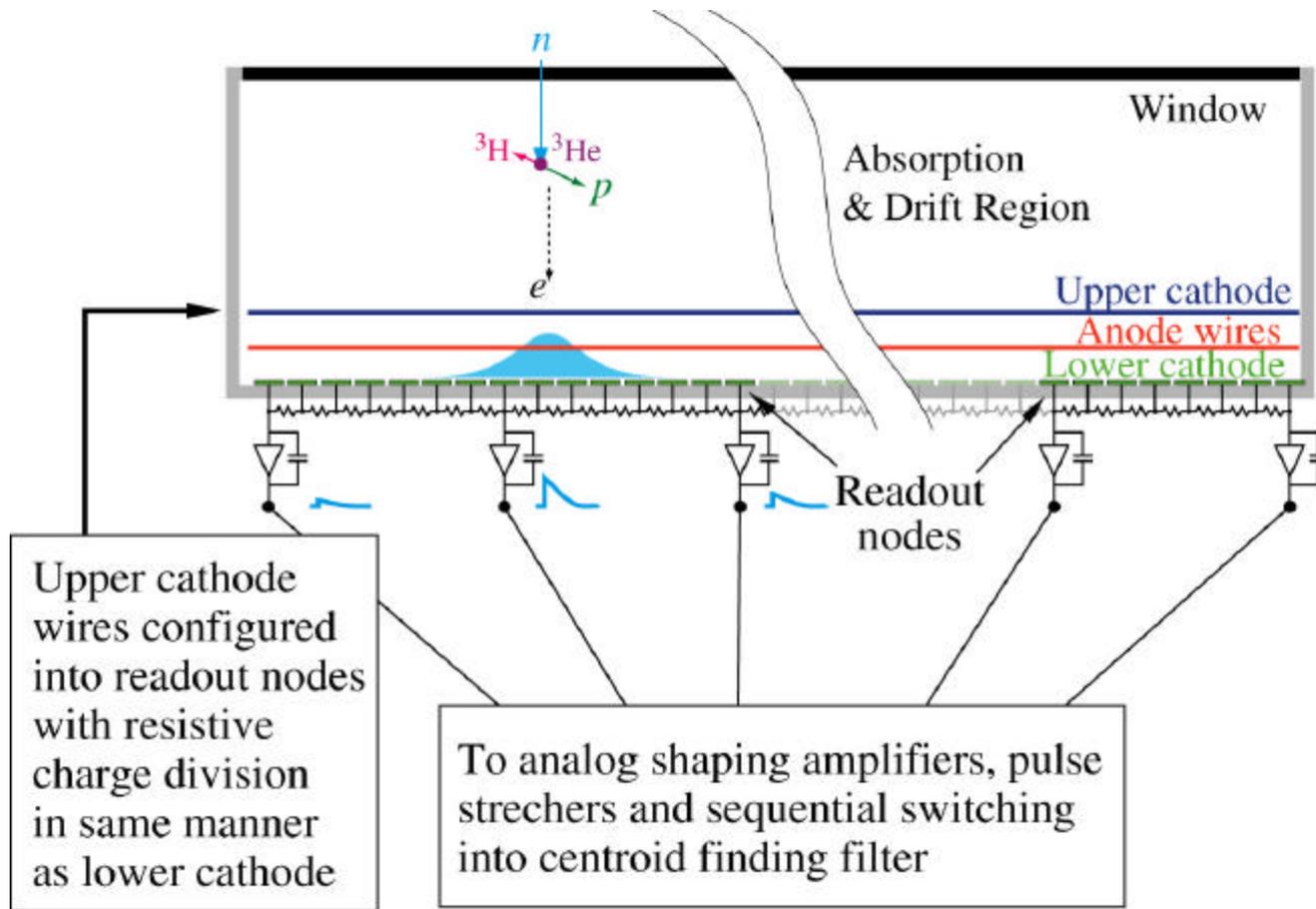


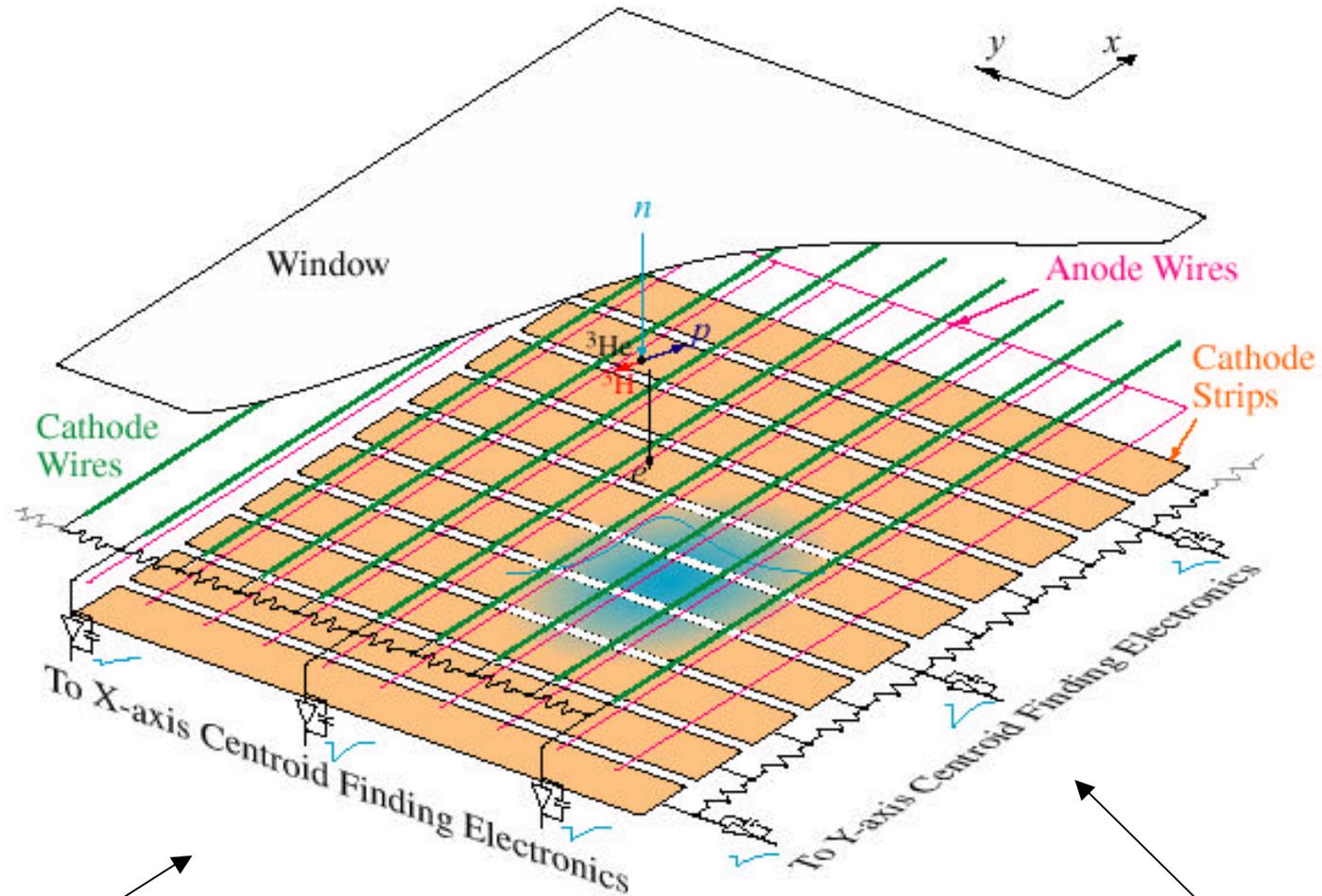
120 degree Neutron Detector installed at LANSCE



Detector Charge Collection



Detector Charge Collection

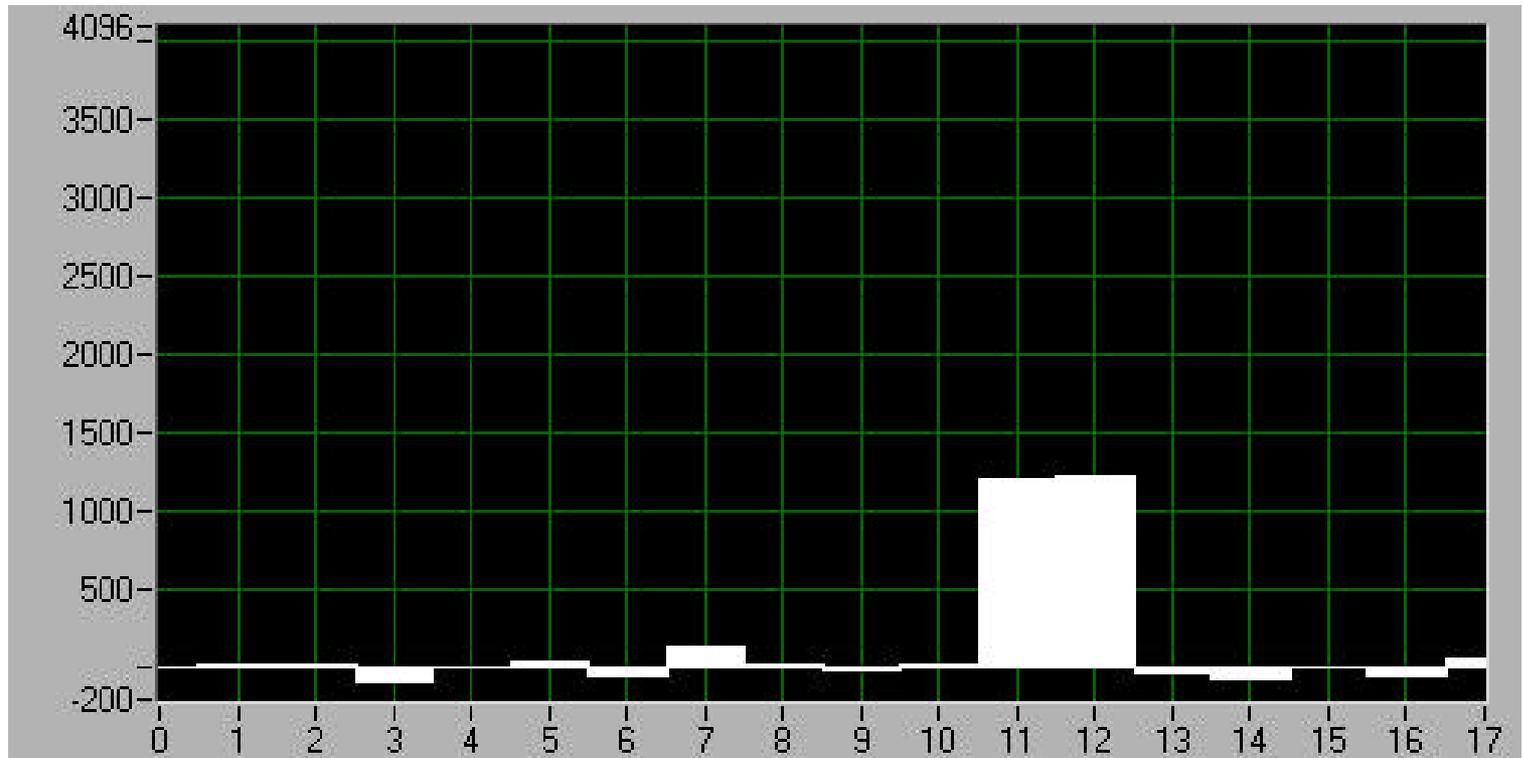


15 readout taps
per segment

17 readout taps
per segment

ADC outputs for Y-axis channels with neutron hit centered between preamps

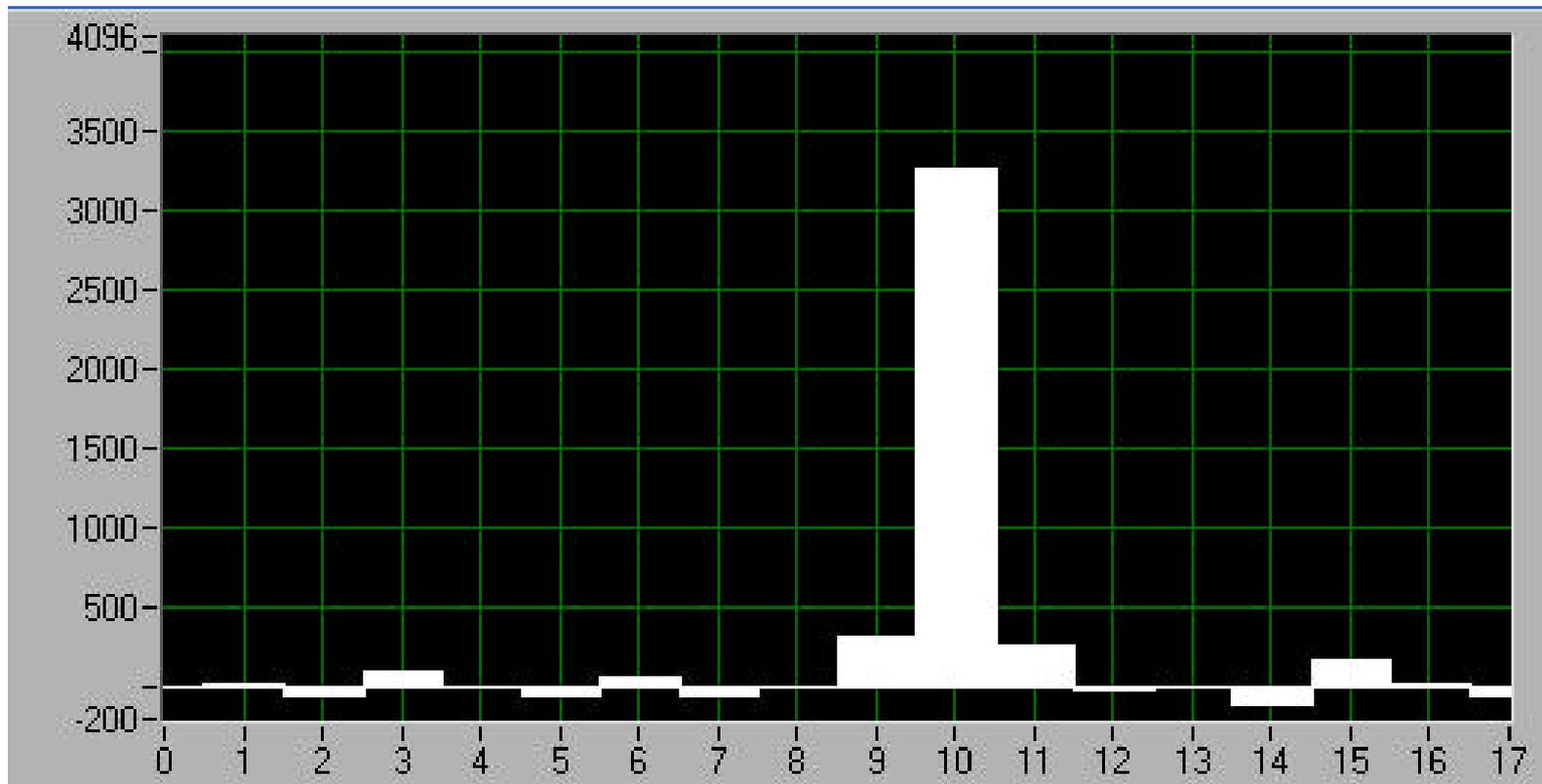
Charge
amplitude



Channel #

ADC outputs for X-axis channels with neutron hit directly over preamp

Charge
amplitude

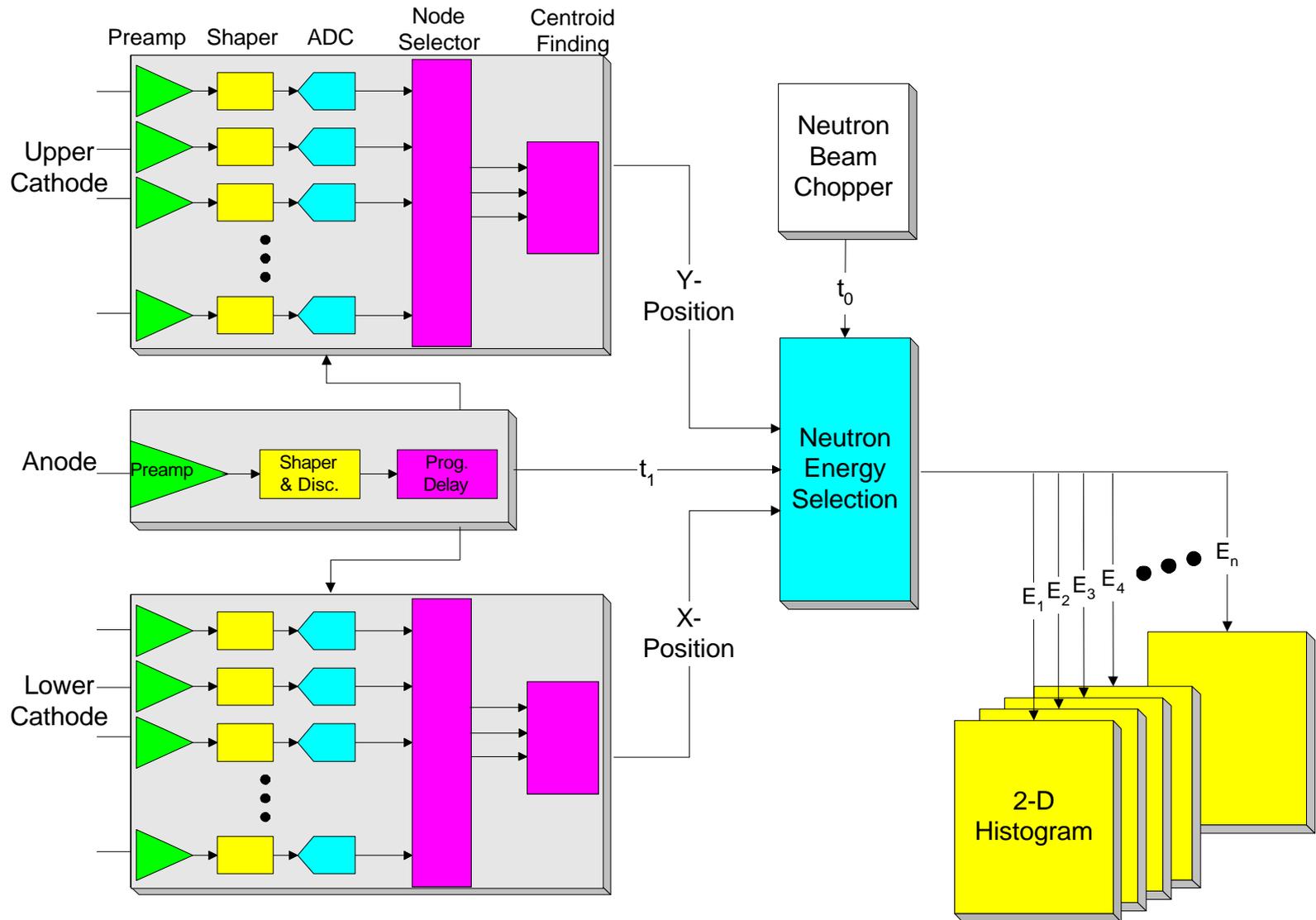


Channel #

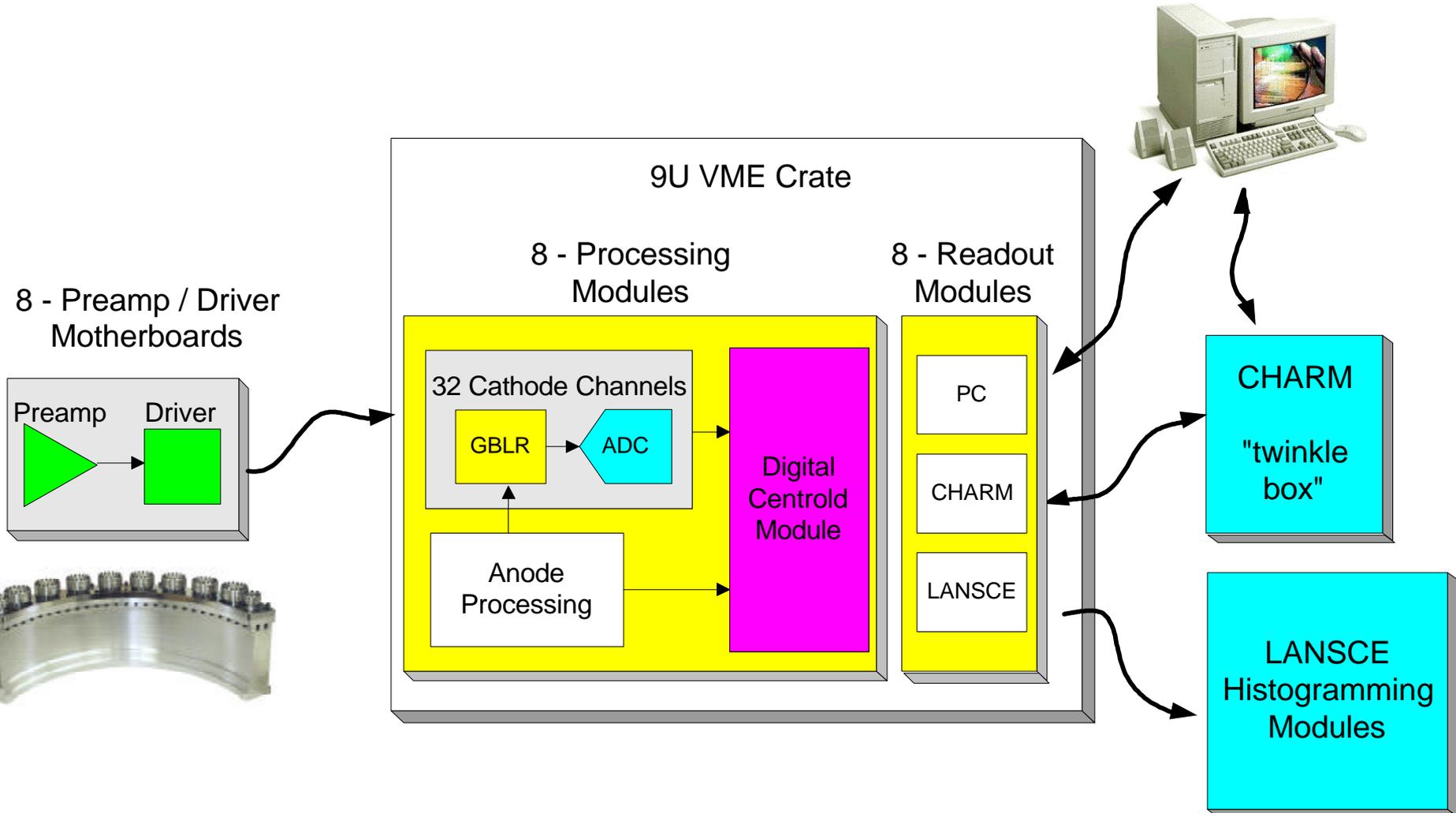
Detector Electronics

- Provide X, Y position for the center of charge in under 4 μ S.
- Provide a set of software tools for calibrating electronics and displaying data.
- Interface to the Los Alamos LANSCE-12 data collection system.

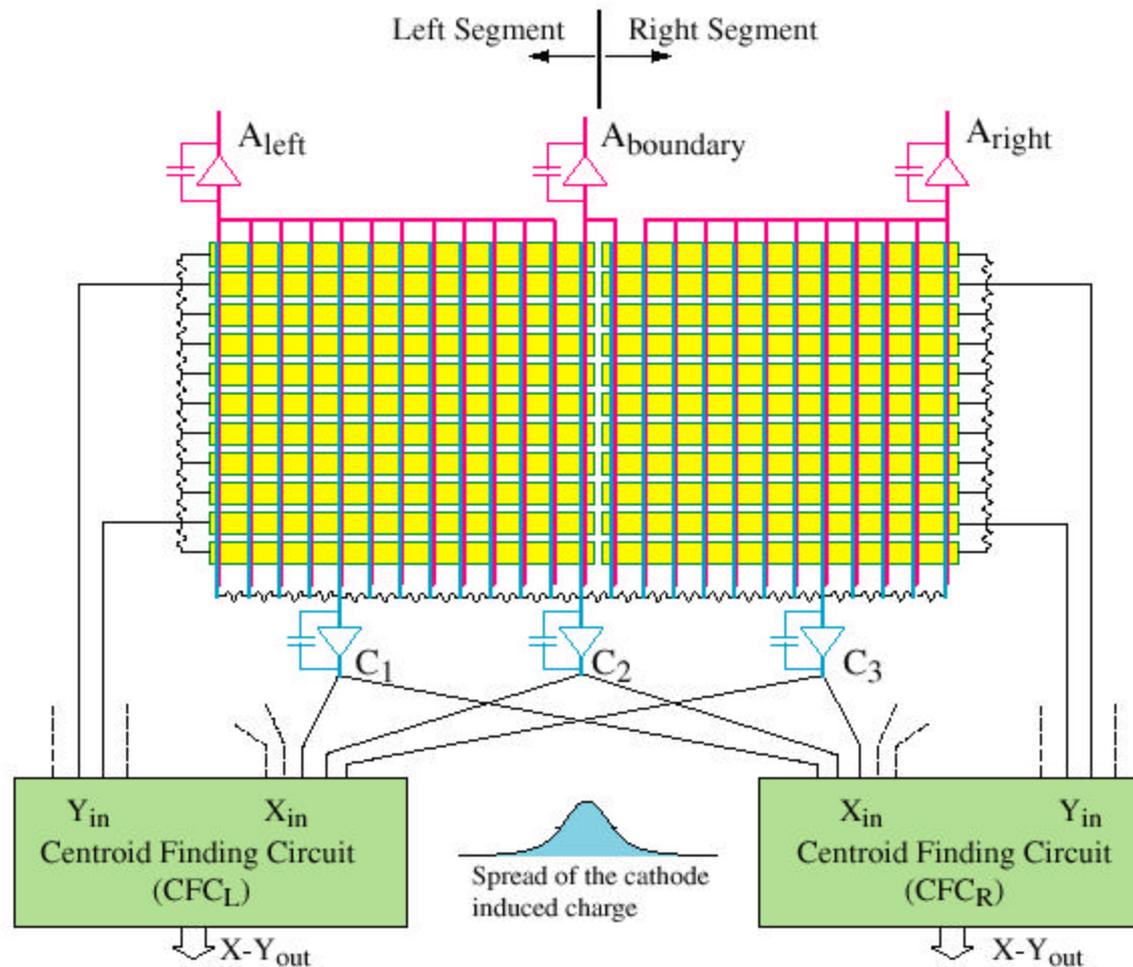
Complete Electronics Chain for 1 Segment



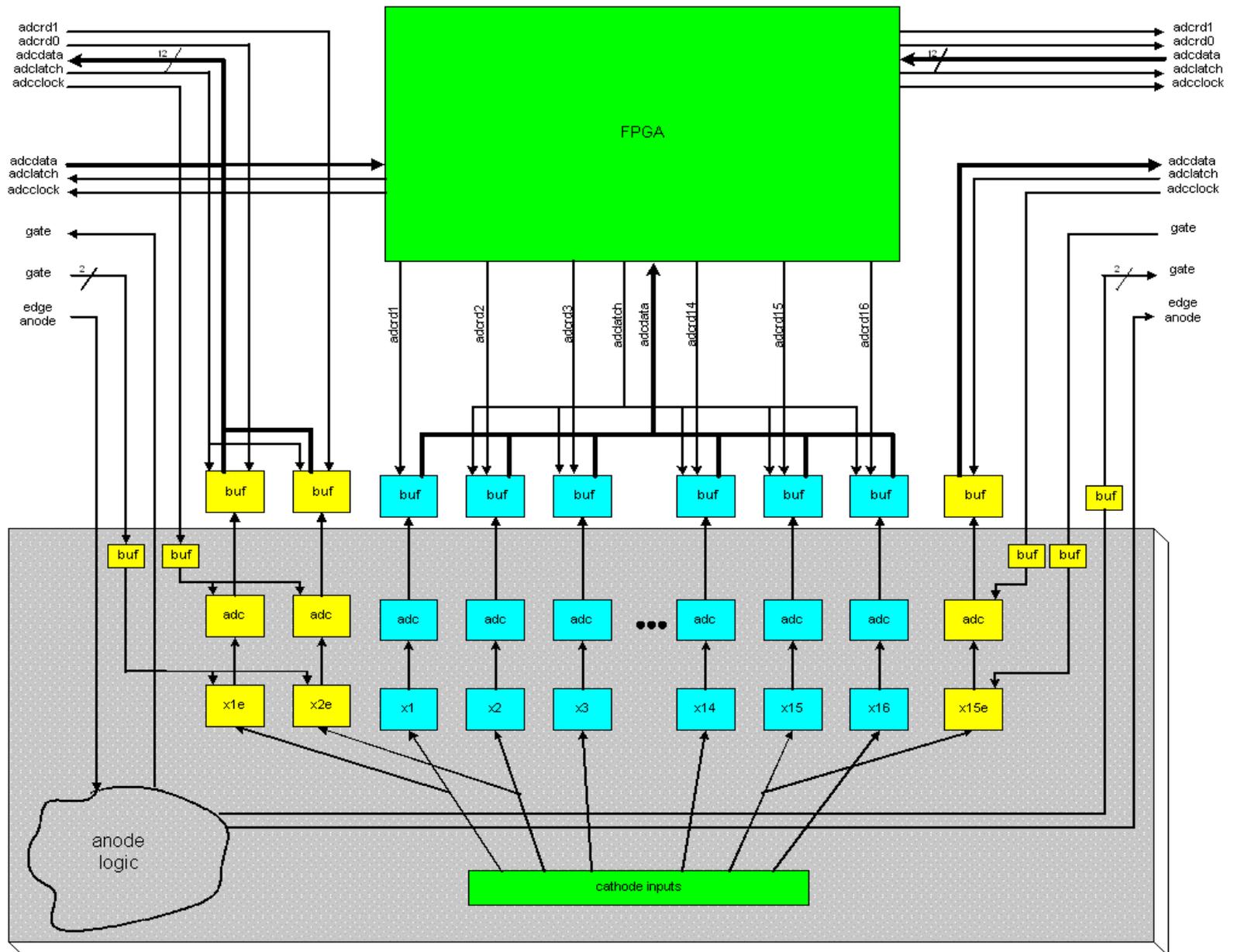
Overall Electronics Block Diagram



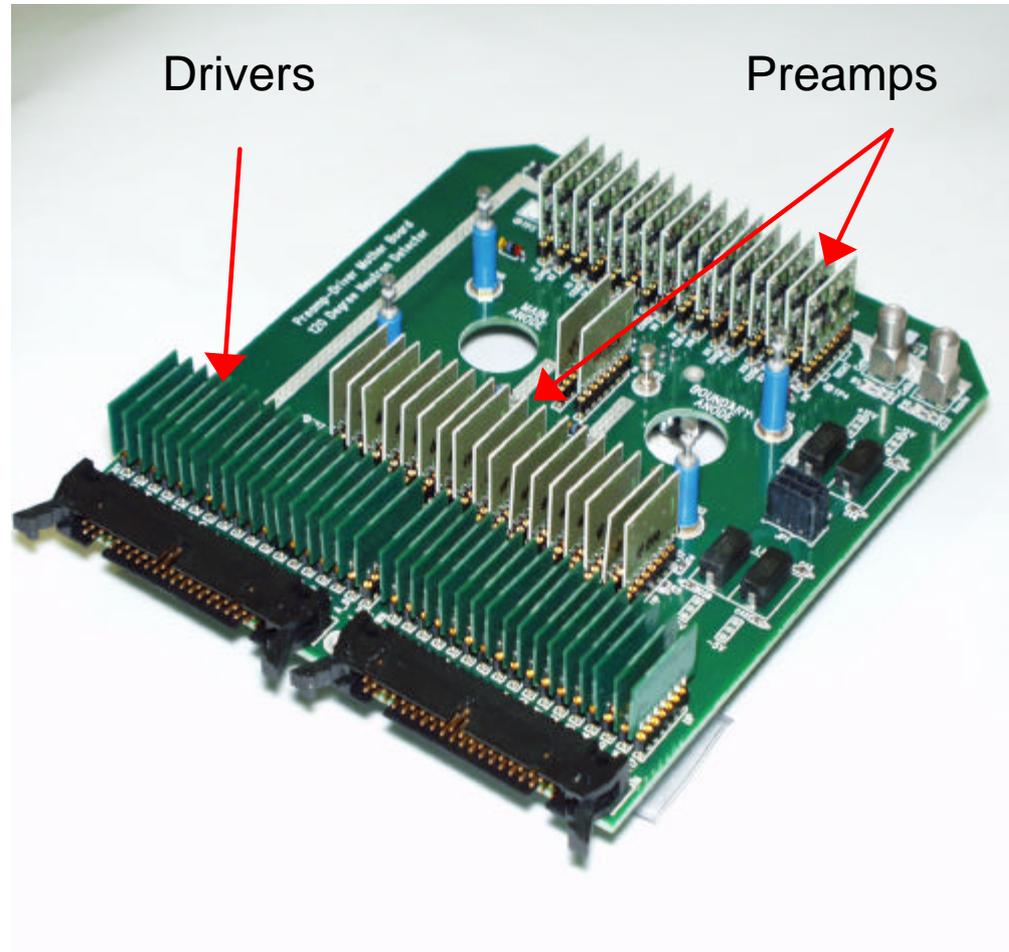
Position Encoding Across Boundaries



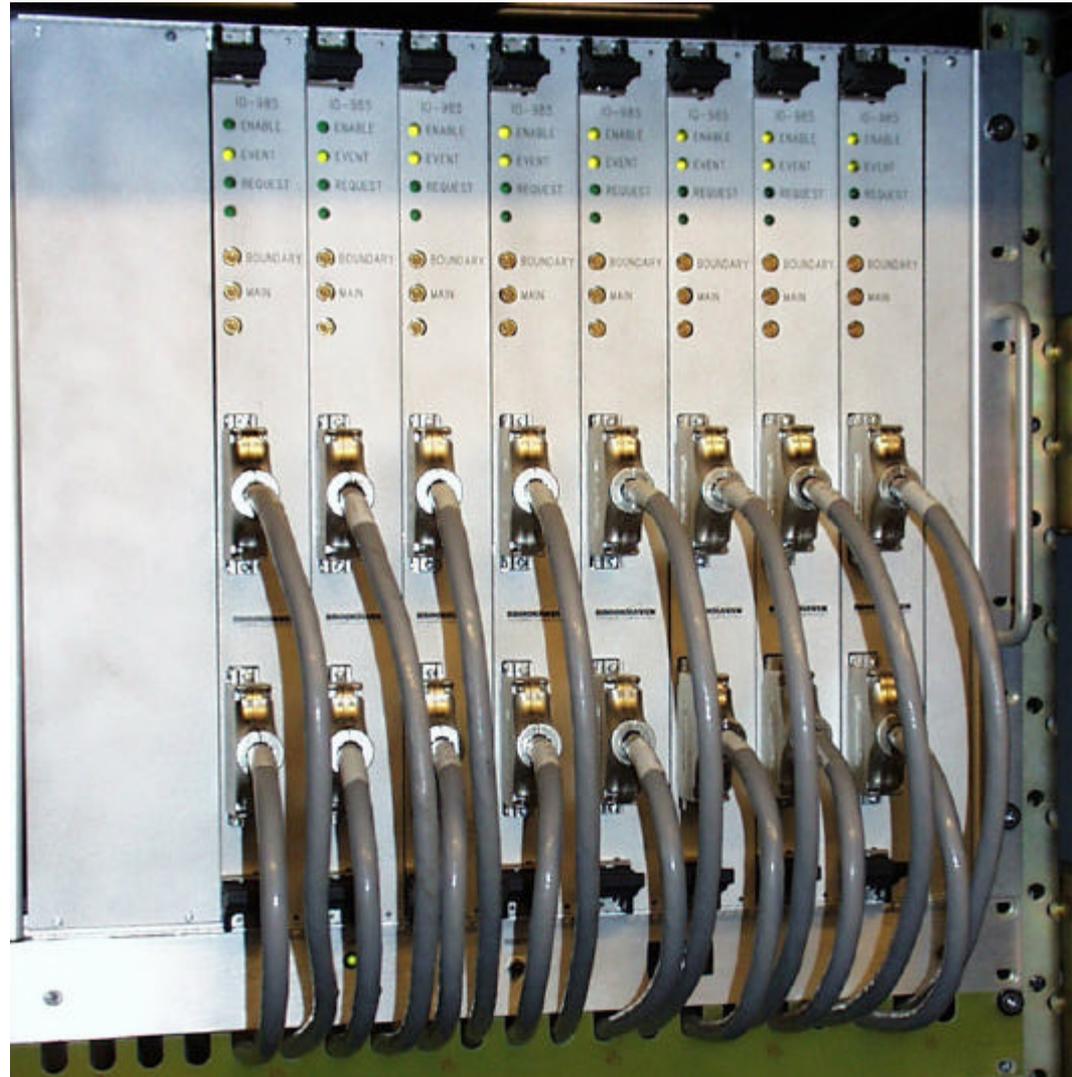
Position Encoding Across Boundaries Implementation



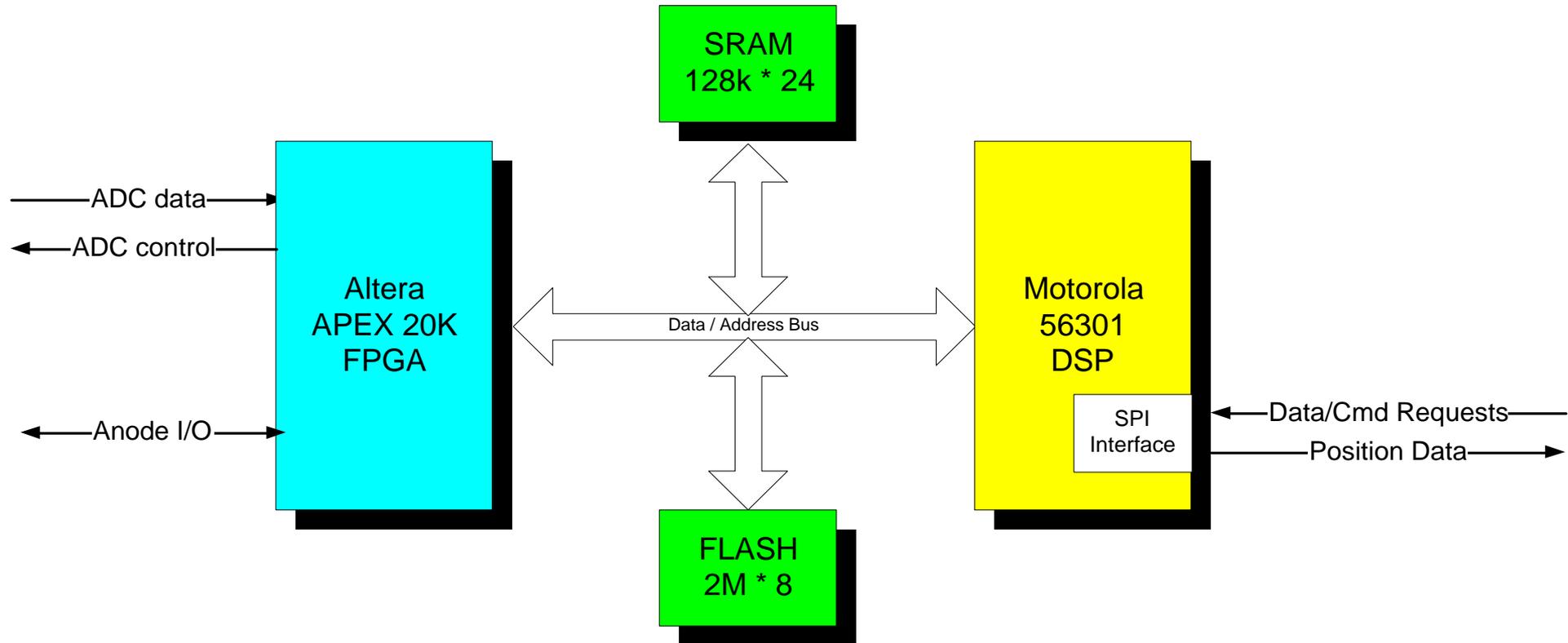
Preamp Driver Motherboard



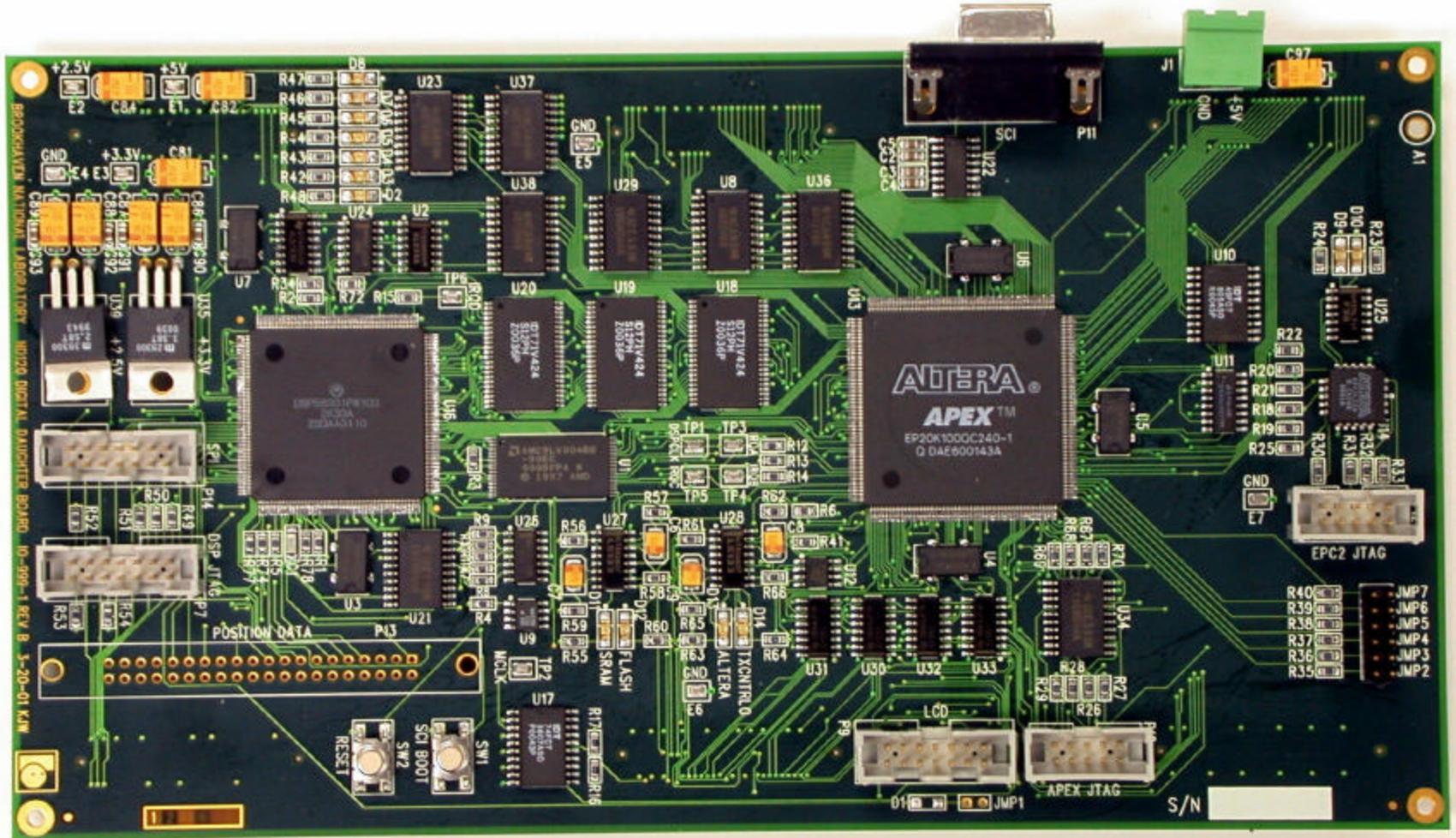
VME Electronics



Digital Daughterboard Block Diagram



Digital Daughterboard

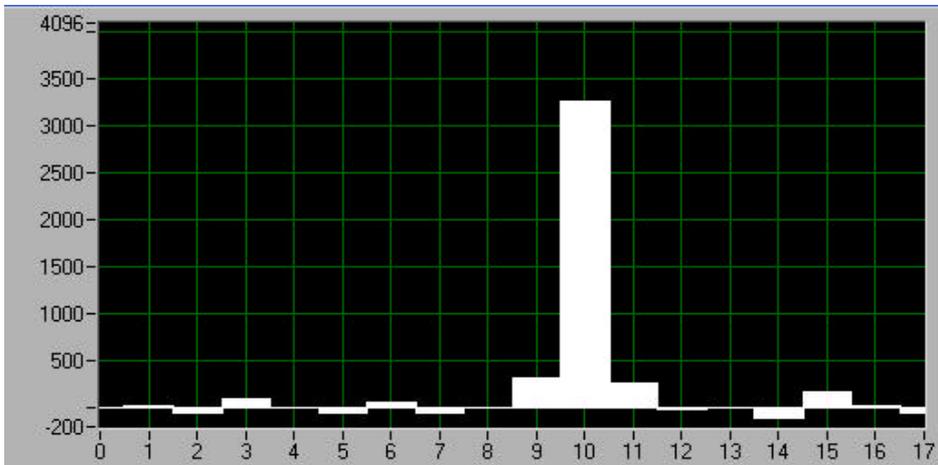


Steps to Calculate the Center of Charge

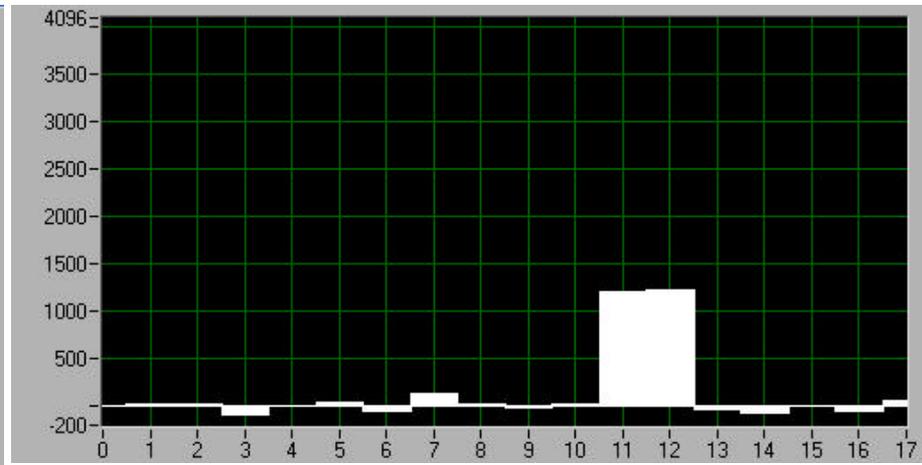
- Read 17 x-axis ADC's, 15 y-axis ADC's, 3 neighbor x-axis ADC's
 - For each channel
 - Offset Correction (subtraction)
 - Gain Correction (multiplication)
 - Search for channel with the maximum charge
 - Calculate center of charge
 - Add Result to Histogram
 - Send Result to Los Alamos Acquisition System
-
- FPGA
- DSP

Center of Charge Equation

$$\left(\frac{c - a}{a + b + c} + \text{node\#}_{\max} \right) \times \text{bins/node}$$



↑ ↑ ↑
a b c



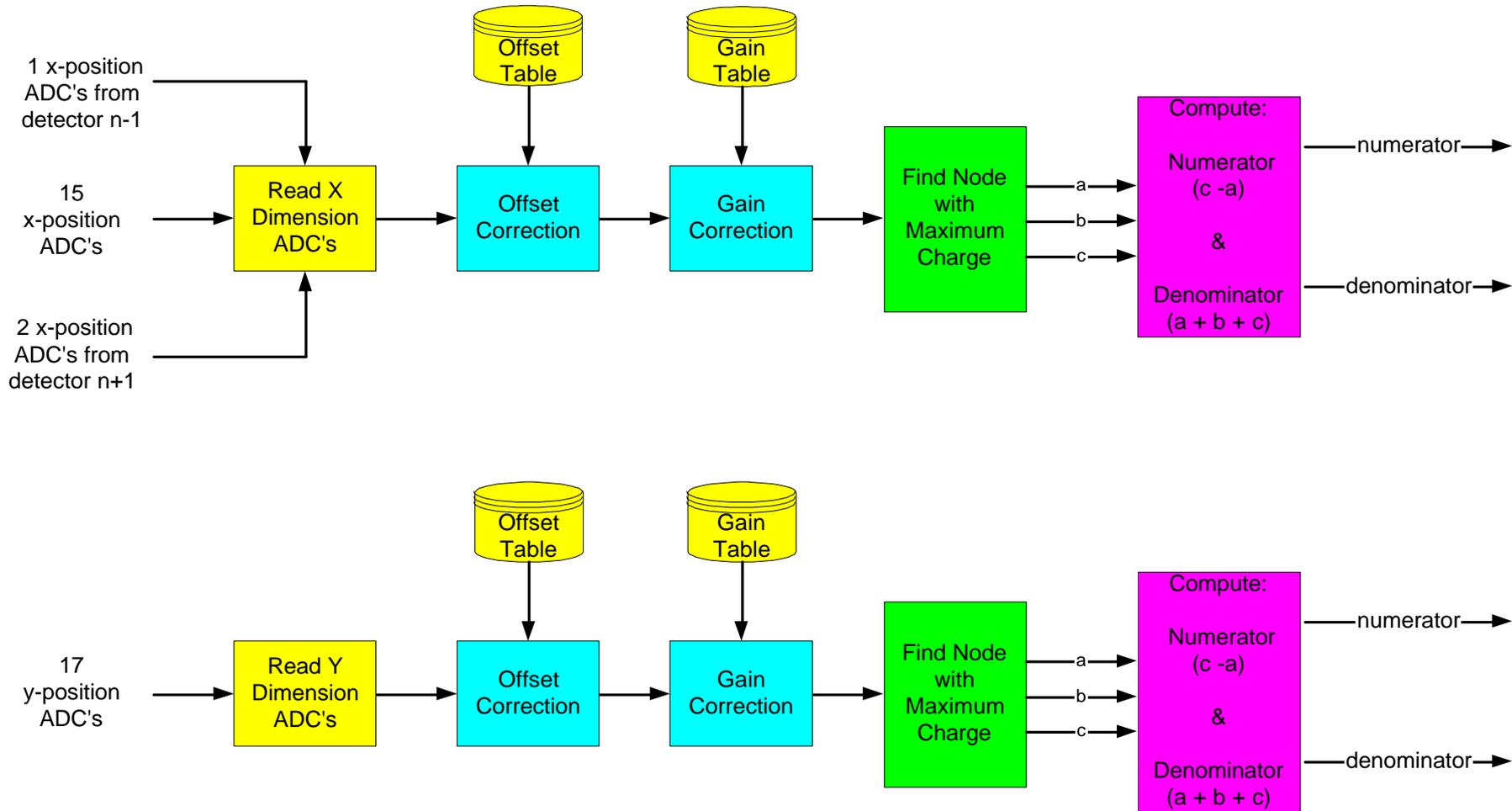
↑ ↑ ↑
a b c

Altera APEX 20K FPGA



- Embedded System blocks
 - Dual-Port RAM, FIFO, RAM, ROM, FIFO
 - RAM sizes up to 440 kbits.
- Support for various I/O standards
 - LVTTL, LVCMOS, LVDS, LVPECL, GTL+
 - Up to 808 user I/O pins
- Signal Tap logic analysis
- Density up to 1.5 million gates
- On chip PLL 1x-160x multiplication
- 0.15um, 6 layer (all copper-20KC) process

FPGA Block Diagram

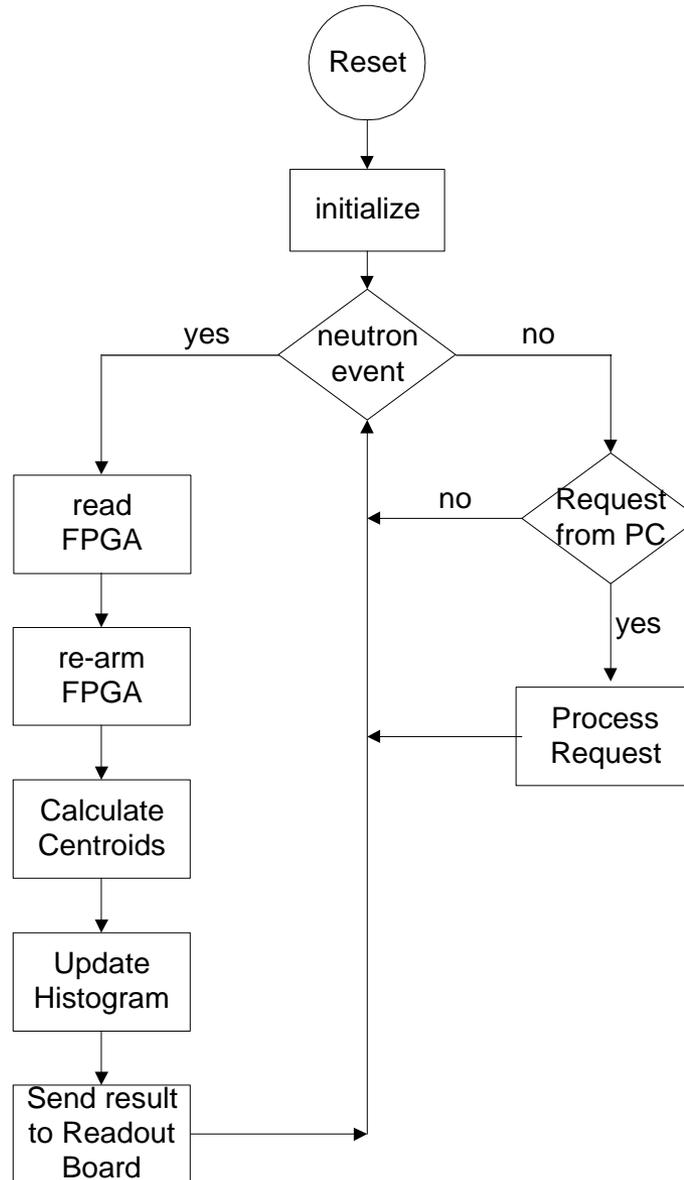


Motorola DSP56301 Digital Signal Processor

- 100 MIPS Performance @ 100Mhz
- On-chip program and data memory
- On-chip SRAM and SDRAM controllers
- Two High Speed Synchronous Serial Ports
- RS-232 Interface
- 40 Programmable GPIO pins
- On Chip debug port



DSP Software Flowchart



Some Supported Request types

- Histogram
 - Dump x,y position histogram
 - Dump Anode Histogram
 - Dump Cathode Sum Histograms
 - Clear histograms
- Dump ADC Data (Diagnostic)
 - Raw Data
 - Offset corrected
 - Offset & Gain corrected
- Calibration
 - Offset Calibration
 - Gain Calibration
 - Dump Current calibration values
- Status
 - Event rate, Anode trigger levels, gain settings, software & firmware versions.

Readout Board



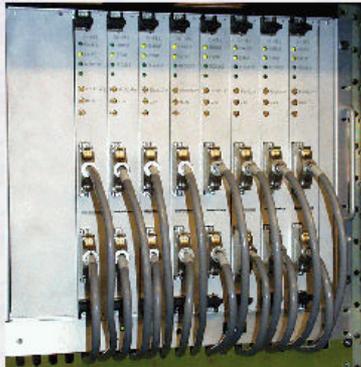
Processed
x,y positions
feed in here

Interface to CHARM
“twinkle” box

Interface to PC via National
Instruments DIO32-HS
Digital I/O module

Interface to Los Alamos
LANSCE-12 data
acquisition system

Neutron Detector Electronics Control & Display Page



Clicking on the links below will start a labview virtual instrument (vi) on the host machine. Once the vi has loaded you can right click on the panel to take control. Due to current licensing limitations, only one client can view these controls at a time...

Status & Control

- [View Detector Settings](#)
- [Change Detector Settings](#)

Histogramming

- [View 1 segment histogram](#)
- [View 2 segment histogram](#)
- [View 8 segment histogram](#)

Diagnostics

- [Display all ADC outputs](#)

Calibration

- [Calibrate](#)

Advanced

- [View Anode Histograms](#)
- [View Cathode Sum Histograms](#)

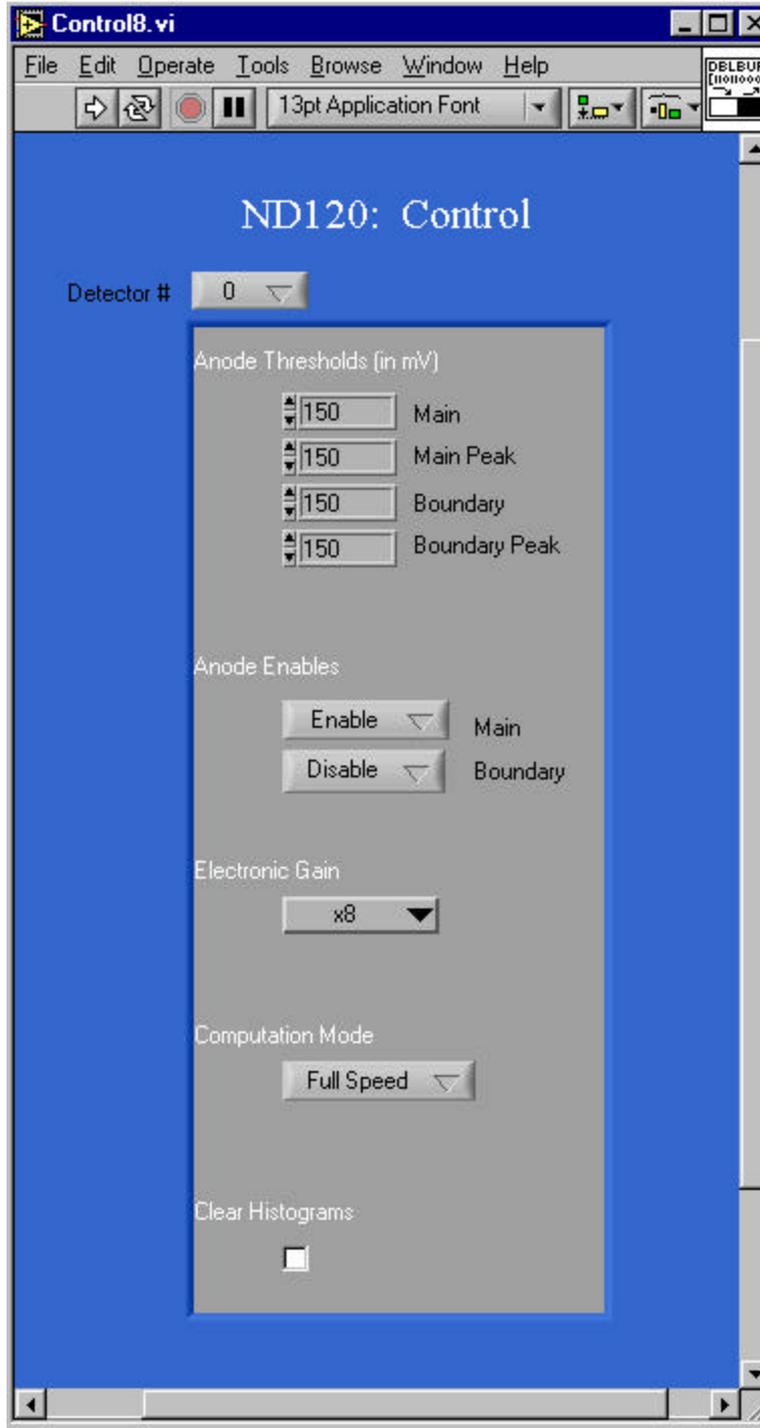
Labview Status vi

The screenshot displays the 'ND120: Status' LabVIEW interface. At the top, the title bar reads 'Operate' and the window title is 'ND120: Status'. The interface is organized into eight columns, one for each detector (Det: 0 to Det: 7). Each column contains several control elements: a 'Rate' display (Counts / sec), an 'Electronic Gain' control, 'Anode Enables' for 'Main' and 'Boundary', 'Anode Thresholds (in mV)' for 'Main', 'Main_Peak', 'Bound', and 'Bound_Peak', and a 'Miscellaneous' section with 'Slot Number', 'Heartbeat', 'Software Ver.', 'FGPA Version', and 'Mode'. Detector 6 and 7 are active, indicated by checked checkboxes. The status for Det 6 and 7 is as follows:

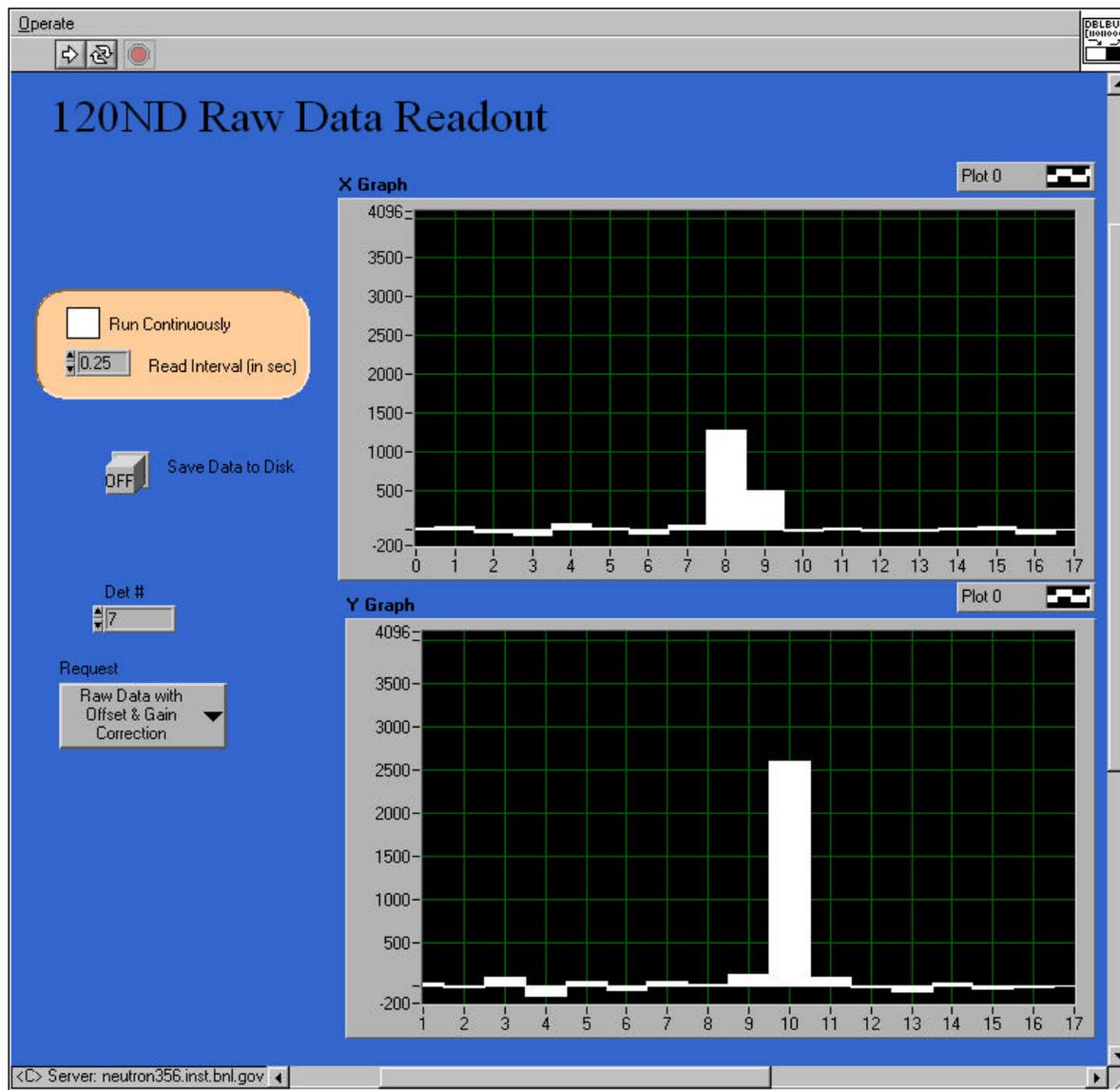
Parameter	Det 6	Det 7
Rate (Counts / sec)	476	442
Electronic Gain	8	8
Anode Enables - Main	Enabled	Enabled
Anode Enables - Boundary	Enabled	Disabled
Anode Thresholds (in mV) - Main	150	150
Anode Thresholds (in mV) - Main_Peak	150	150
Anode Thresholds (in mV) - Bound	150	150
Anode Thresholds (in mV) - Bound_Peak	150	150
Miscellaneous - Slot Number	6	7
Miscellaneous - Heartbeat	412374	412380
Miscellaneous - Software Ver.	34	34
Miscellaneous - FGPA Version	15	15
Miscellaneous - Mode	Full Featured	Full Featured

The status bar at the bottom left shows '<V> Server: neutron356.inst.bnl.gov'.

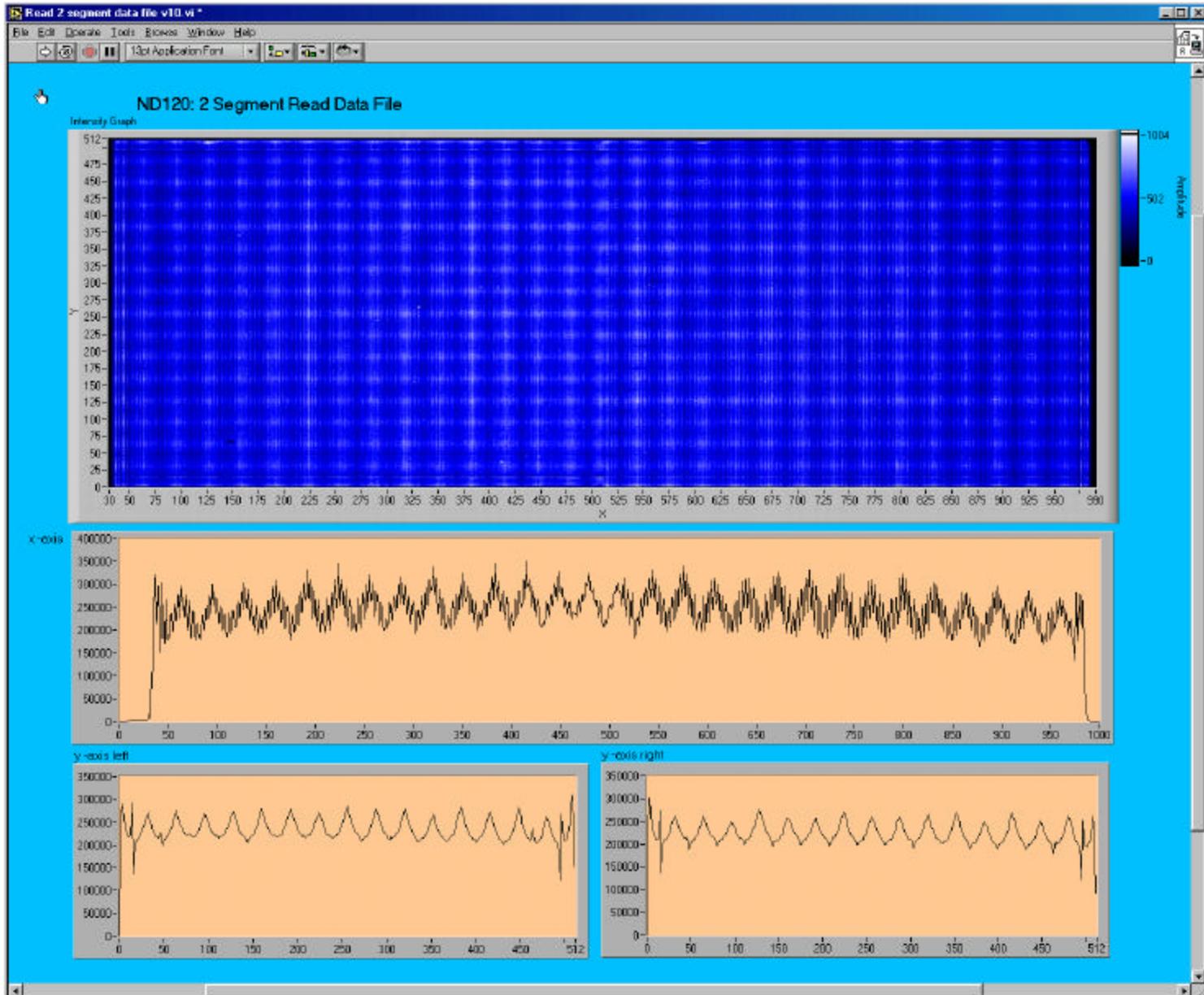
Labview Control vi



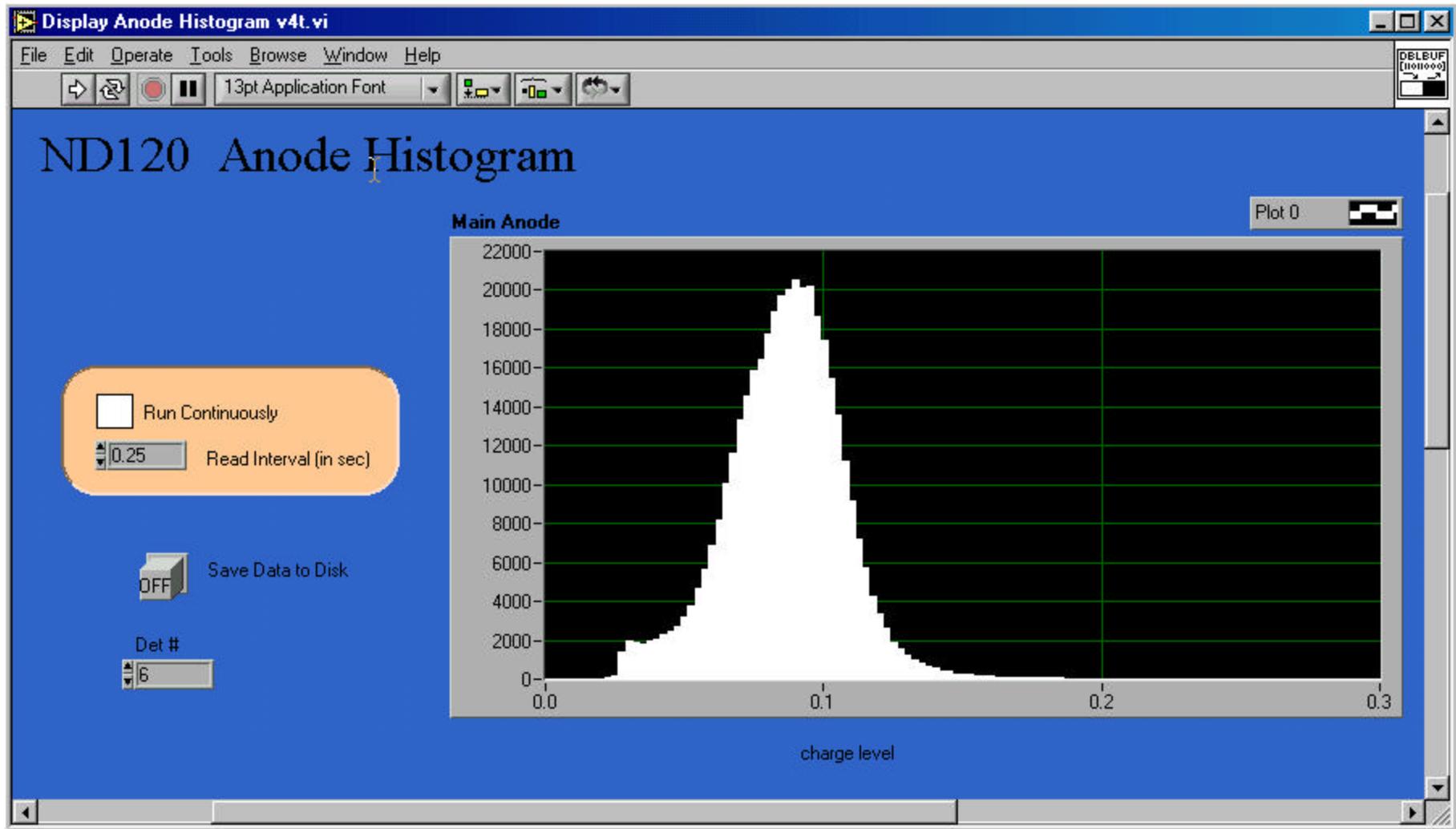
Read ADC outputs vi



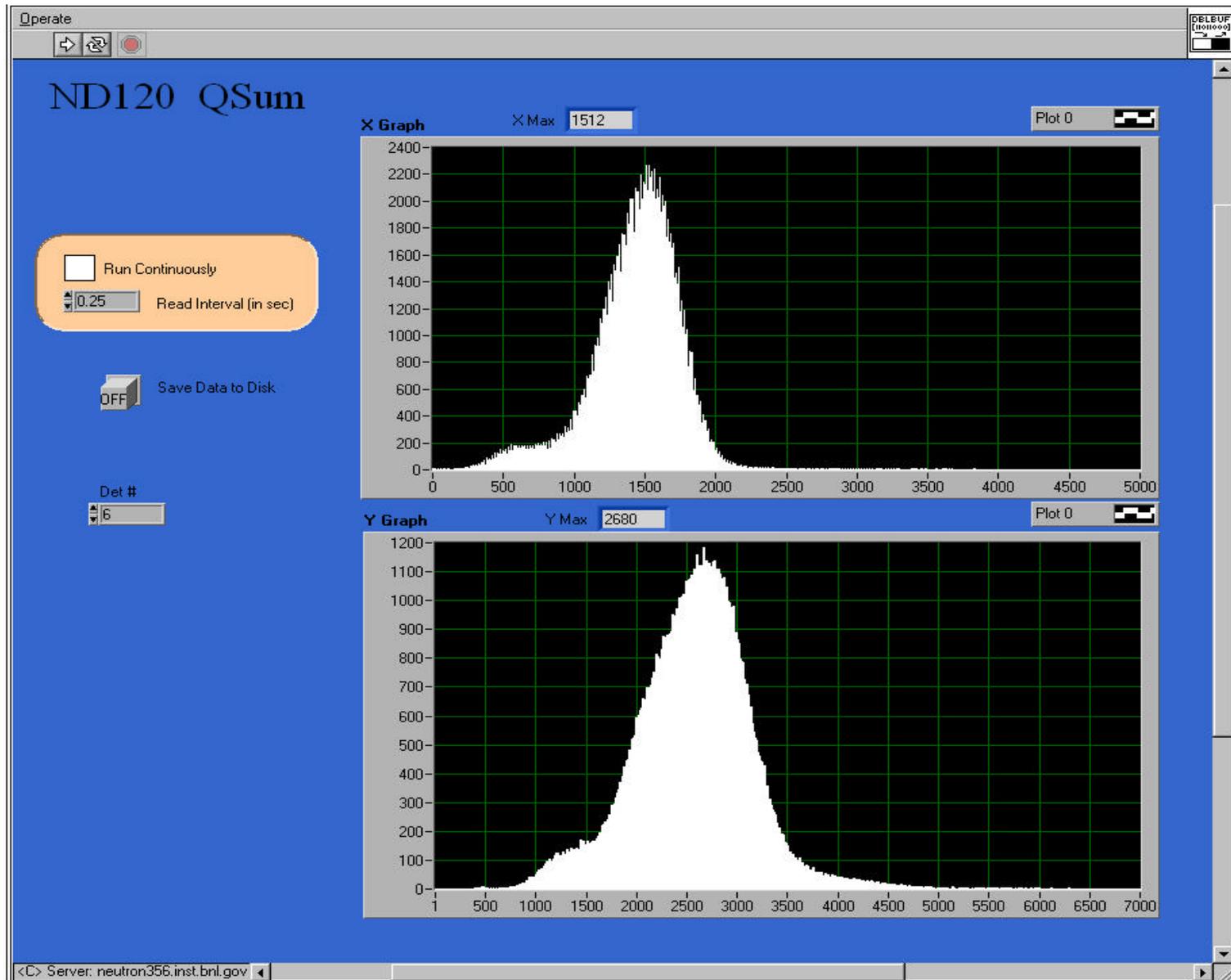
Display 2 Segment vi



Display Anode Histogram vi



Display Cathode Sum vi



Calibration

Calibration8 v22.vi

File Edit Operate Tools Browse Window Help

13pt Application Font

ND120: Calibration

Det#

Function
View Offset & Gain Coefficients

Procedure

1. Turn off High Voltage
2. Disable Boundary Anode. Note: use Control8.vi
3. Turn on pulser. Note: move switch from ext to high
4. Do Offset Calibration.
 - a. Disconnect cathode pulser
 - b. Select Function to Offset Calibration
 - c. Cycle through each detector segment.
5. Do Gain Calibration.
 - a. Reconnect cathode pulser
 - b. Set cathode pulser voltage dial to 069
 - c. Select Function to Gain Calibration
 - d. Cycle through each detector segment.
6. View Offset & Gain Results. (optional)
7. Turn off pulser. Note: move switch from high to ext
8. Enable Boundary Anode. Note: use Control8.vi
9. Turn back on High Voltage

Save Data to Disk

Offset & Gain Coefficients

X Offset Graph

Segment	Offset
0	0
1	280
2	250
3	300
4	260
5	270
6	300
7	310
8	290
9	280
10	270
11	320
12	270
13	200
14	320
15	260
16	320
17	320

X Gain Graph

Segment	Gain
0	0.0
1	1.0
2	1.0
3	1.0
4	0.95
5	1.0
6	1.0
7	0.95
8	1.0
9	1.0
10	0.95
11	1.0
12	0.95
13	1.0
14	1.0
15	0.95
16	1.0
17	1.0

Y Offset Graph

Segment	Offset
1	300
2	250
3	330
4	340
5	300
6	330
7	340
8	310
9	350
10	300
11	350
12	280
13	280
14	310
15	320
16	270
17	300

Y Gain Graph

Segment	Gain
1	1.0
2	1.0
3	1.0
4	1.0
5	1.0
6	1.0
7	1.0
8	1.0
9	1.0
10	1.0
11	1.0
12	1.0
13	1.0
14	1.0
15	1.0
16	1.0
17	1.0

An X-ray Transmission Image of a Copper Mask

(5.9keV x-rays, 0.1pC anode charge, Ar/CO₂ 20%)

